
Problem-based learning in American medical education: an overview

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The recent trend toward problem-based learning (PBL) in American medical education amounts to one of the most significant changes since the Flexner report motivated global university affiliation. In PBL, fundamental knowledge is mastered by the solving of problems, so basic information is learned in the same context in which it will be used. Also, the PBL curriculum employs student initiative as a driving force and supports a system of student-faculty interaction in which the student assumes primary responsibility for the process. The first PBL medical curriculum in North America was established at McMaster University in Toronto in 1969. The University of New Mexico was the first to adopt a medical PBL curriculum in the United States, and Mercer University School of Medicine in Georgia was the first U.S. medical school to employ PBL as its only curricular offering. Many interpretations of the basic PBL plan are in use in North American medical schools. Common features include small-group discussions of biomedical problems, a faculty role as facilitator, and the student's relative independence from scheduled lectures. The advantages of PBL are perceived as far outweighing its disadvantages, and the authors conclude that eventually it will see wider use at all levels of education.

The recent trend toward problem-based learning (PBL) amounts to one of the most significant changes in American medical education since the Flexner report instigated global university affiliation. Interest in medical PBL has been driven by three major factors: a need to accommodate the growing volume of knowledge required to practice medicine, the General and Professional Education of the Physician (GPEP) report [1] and, perhaps most important, the implementation of a successful PBL curriculum at McMaster University [2]. Many schools now are investigating the PBL concept, and some will adopt it within the next decade. It is important, therefore, that medical educators understand the basic structure of PBL and appreciate its advantages and limitations.

WHAT IS PBL?

PBL is a form of education in which information is mastered in the same context in which it will be used. Also, in its most recent medical forms, PBL is seen as

a student-driven process in which the student sets the pace and the role of the teacher becomes one of guide, facilitator, and resource.

Contemporary PBL medical programs usually employ two fundamental principles: basic sciences are learned in the process of analyzing typical cases, and learning is motivated by student curiosity. These two elements are manifest in many different ways. For example, in analyzing a case, the student always comes to a point where more information is needed to continue. This results in the generation of an "issue." An issue specifies an item of information that must be learned to complete the case. It always is stated in the form of a question, such as "What are opsonins and how do they work?" Once an issue has been identified, it becomes a learning goal for the next meeting. Each student then must find an answer to this question and be prepared to share it with other students. Thus, PBL employs student initiative as a driving force. The student generates the issues, provides the answers, and teaches fellow students.

The use of teaching cases in a conventional course, as practiced by many schools, appears similar to PBL, but the role of the student is far more passive. In authentic PBL, the student is asking the questions as well as answering them, teaching as well as learning, assuming primary responsibility for the process. According to a recent issue of *JAMA* devoted to medical education, 100 medical schools had reported the use of PBL [3]. On closer inspection, however, it becomes apparent that most of this activity is case-enhanced teaching. While this is an effective learning mode, it is not a true PBL exercise, in that student initiative is not the impetus.

GOALS OF THE PBL CURRICULUM

As used in medical education, the PBL curriculum is intended to meet three goals: the student must acquire a body of basic biomedical knowledge equivalent to that learned in a traditional curriculum, the student must learn to apply this basic knowledge in patient care, and the student must acquire the attitudes, habits, and techniques of a lifelong learner.

The first goal is identical to the central goal of a conventional curriculum. Any successful medical curriculum must transmit an adequate store of biomedical facts, or it will not survive the usual gauntlet of extramural evaluation. In the PBL curriculum, however, provisions are made to meet the second and third goals as well. Through the process itself, the student gains the ability not only to recite biomedical information but also to use it in solving problems. Indeed, the very means by which learning is accomplished is the solving of biomedical problems. Regarding the third goal, the student's constant use of textbooks, literature references, consultations, and other media impart the habit of learning and professional interaction. In fact, it is the authors' impression that the PBL student comes to depend on texts and other library material far more completely than do students in a traditional program. PBL students are conditioned to correct any lack of information immediately as a case develops. They are not just advised to be lifelong learners; they are trained to be.

HISTORY OF PBL IN NORTH AMERICA

The present burst of interest in the problem-based medical curriculum began at McMaster University in 1969 [4]. In the McMaster setting, PBL was adopted as part of a comprehensive reorganization, which also included the selection of students with nontraditional educational backgrounds and complete integration of basic biomedical sciences into a single program. McMaster's example was soon followed by other North American medical schools. In 1979, The University of New Mexico (UNM) became the first med-

ical school in the United States to offer a PBL curriculum. Its approach was to institute PBL as an alternative track and to maintain a concurrent conventional curriculum as the standard instructional format. Most UNM students learn through a traditional, lecture-based curriculum, while a small number pursue PBL [5].

It was not until 1982, when Mercer University established its School of Medicine (MUSM), that a U.S. undergraduate medical institution began operating with full commitment to PBL. The MUSM opened its doors as a PBL school with complete basic science integration and never has offered a conventional curriculum. Another milestone in the history of PBL was its adoption by Harvard University School of Medicine, first as an alternative track and later as standard for all medical students [6].

Harvard and Bowman Gray medical schools are notable in the history of PBL because they represent established schools that have converted to PBL from a traditional medical curriculum. Although such a transformation is expensive and politically difficult, in both cases the project seems to have been successful.

While many medical schools around the world use PBL, to the author's knowledge only four North American schools currently offer only a problem-based curriculum with no conventional curriculum as a supplement or alternate. These four are McMaster, Mercer, Harvard, and Hawaii. Several medical schools offer some version of a dual-track system in which a small part of the class uses PBL. Some schools offer a single curriculum that blends both concepts, that is, an integral PBL "stream" that parallels and reinforces a traditional curriculum. Other schools employ a problem-based course, a PBL elective, or even a PBL third year. In all, many interpretations of the PBL curriculum exist, none of which are absolutely "pure." In fact, many educators believe that a PBL curriculum is strengthened by a limited number of well-chosen lectures.

PBL AT MERCER UNIVERSITY

Since it opened in 1982, MUSM has been committed to an integrated, problem-based, community-oriented preclinical curriculum. This curriculum is centered around the education of the family practice physician. In fact, the training of family practitioners always has been MUSM's declared intention. The entire basic science program is administered by only two departments, the Department of Basic Science and the Department of Pathology. Except for pathology, there are no discipline-based administrative units involved in basic science education.

The basic science component of the preclinical curriculum is integrated fully. No discipline-oriented

courses are offered, no discipline-related examinations are given, and virtually no discipline-centered lectures are scheduled. The two sponsoring departments work together very closely to manage an instructional program that is almost completely devoid of the usual divisions of information [7].

As in other PBL programs, the MUSM lecture schedule is replaced by a series of tutorial sessions. During each session, a group of six students meets with one faculty member to discuss actual case problems. Case study and analysis compose the very foundation of basic science education. It is important to recognize that all basic science information is learned by participation in this case analysis program. There is no other track. At MUSM, three 3-hour tutorial meetings are held each week. Attendance and participation are mandatory.

As they pursue the basic science program, MUSM students are taught clinical skills and community science. In these programs, students interact with simulated patients and spend a number of afternoons in preceptorship training with local primary-care practitioners. Somewhat surprisingly, the basic and clinical components have proven to be complementary. Because the Biomedical Problems Program is conducted through small-group meetings, the students' practical experiences actually are discussed during basic science training. (This is a wonderfully synergistic feature, not anticipated in the original design of the curriculum). In this way, real-life clinical practice in a rural community becomes a laboratory exercise for the illustration of basic science theory. Also, and even more unprecedented, basic science becomes applicable to the care of patients. This would be next to impossible in a conventional, lecture-based curriculum.

THE PBL CURRICULUM

The PBL curriculum, as used in medical education, usually involves at least five features, which are described in the following summaries.

The biomedical problem

The biomedical problem is a typical case of a disease chosen to illustrate the area of basic science to be studied. Analysis of this case results in the generation of issues, always in the form of questions. Answering these questions provides the facts needed to build the student's fund of knowledge.

At MUSM, approximately 150 cases are studied in the two-year preclinical curriculum. Of these, 137 are used for teaching and 13 for oral examinations. Cases may be real or fictional and are selected to provoke issues appropriate for each major subject. For example, a case of lung cancer is used in the twelfth week,

during a curriculum phase dealing with disorders of growth. In studying this case, students learn the basic concepts of cancer, including genetics, carcinogenesis, classification and nomenclature, why people die from cancer, and as much other information as can be absorbed in the time available.

The small-group tutorial session

Small-group tutorial meetings serve as the center of learning in the PBL curriculum. A group typically consists of six to seven students and one or two faculty members. Generally, everyone sits around one table as equals. A blackboard and large paper tablets are available for developing issues. The faculty overseer is expected neither to be the source of all information nor even to have information about every area being discussed. His or her function is to serve as an informed facilitator who keeps student participation balanced and knows enough to prevent gross mistakes and avoid too much digression.

In the MUSM version, tutorial meetings occur on Monday, Wednesday, and Friday mornings, from 9:00 A.M. to noon. The curriculum is divided into thirteen phases, each of which lasts for six weeks. A group and its tutors meet for one phase, after which new groups with new tutors are formed.

Student-directed learning

Issues are generated by students. The faculty facilitator assigned to each group does not take the lead or specify what the students are to know. In the give-and-take of a small-group session, everyone serves as learner and teacher. Once all issues are generated, the students arrange them into a priority sequence that becomes the agenda for the next meeting. At the next session, students share their answers to outstanding issues and identify another list to be covered at the following session. In this way, the students determine what they will learn (within limits), how they will learn, and how they will participate in the instructional process. A set of learning objectives is provided for each phase, but it usually is employed as a checklist in preparing for the examination.

Dependence on tutorial learning

Perhaps the most salient characteristic of PBL is the central importance of the small-group meetings. The sequence of subjects considered at these meetings sets the schedule. Although lectures are not regarded as a primary mode of instruction, they are used to some extent by most PBL schools. At MUSM, for example, students may listen to one or two basic science lectures a week, but attendance is not mandatory.

Reciprocal student-faculty evaluation

The typical PBL program usually contains provisions for both student and faculty evaluation. At MUSM, students are evaluated by both intramural and extramural means. A 200-item, multidisciplinary, objective examination and a forty-minute case-analysis oral examination are given at the end of each of the thirteen curricular phases. In addition, each student must pass step 1 of the United States Medical Licensing Examination series before being admitted to clinical training. Faculty evaluation by students also is part of the end-of-phase ritual. Each student completes a detailed report on the tutor, including both standard forms and free form comment.

BENEFITS OF THE PBL CURRICULUM

Most faculty who have taught in both conventional and PBL curricula favor the latter, largely because it seems a more natural format for learning and contains many built-in motivational features. For example, no PBL student would make a practice of coming to tutorial sessions unprepared. This may happen occasionally, but, if it becomes routine, other members of the group will complain loudly that the student is not supplying an equitable amount of information. Students routinely prepare for each tutorial session with five to eight hours of study. In contrast, most students in a lecture-based program do not study until after the class meeting is over.

A second benefit of PBL is that students become skilled at an eclectic style of learning. MUSM students employ texts, monographs, periodical literature, and a wide variety of other sources. Overemphasis on a lecture tends to discourage this. Often, in a traditional curriculum, many students may skip lectures altogether. Having failed to receive current, scheduled information firsthand, they will come to depend on notes and other handout material prepared by the professor. This is never the case in a PBL format, where many different resources must be consulted. In fact, it is not uncommon for PBL students to come up with conflicting information and have to reconcile the differences in group discussion. This leads to the realization that there may be more than one answer to a question and serves to develop a habit of critical thinking.

Owing to longer hours of closer student-faculty contact, the PBL curriculum is perceived by the student as more egalitarian than the conventional curriculum and seems to promote better student-faculty relationships. Also, although evidence is largely anecdotal at this time, many clinicians believe that PBL students adapt more readily to the clinical clerkship than do other students.

DRAWBACKS OF THE PBL CURRICULUM

Reported disadvantages of the PBL curriculum include cost, high faculty workload, variable tutor quality, and the need for supplemental training in gross morphology. The cost disadvantage relates primarily to faculty time expenditure. One study [8] reported that it takes between 500 and 600 hours of faculty time to provide 130 hours of lecture in a traditional medical school. This does not vary appreciably whether student enrollment is 10 or 300. The cost per student is not fixed and actually decreases with greater student numbers. In the PBL curriculum, however, the cost per student is more or less fixed and increases in direct proportion to the size of the student population. This is because one faculty member is required for each group of six students. The two curricular styles seem to incur approximately equal cost when student populations number about fifty. They are not exactly comparable, however, because in a conventional curriculum, perhaps only about one third of the students attend lectures. This raises the actual cost per student to a much higher level.

FUTURE OF THE PBL CURRICULUM

PBL creates a stimulating and supportive environment in which to teach and learn. Its educational efficacy is well established, and faculty who have used it have become its most devoted supporters. The economic issues are authentic but are related to scale and are not insurmountable.

The greatest barrier to PBL may be political. Adoption of a PBL curriculum necessitates a radical change in faculty and administrative attitudes. Faculty must become more exposed to students, departments must relinquish some curricular authority, curricular matters must assume a more important status. Such changes are not easy to enact in an established, conventional school. The advantages of PBL are persuasive, however, and the authors feel that the future will bring even greater use of PBL at all levels of education.

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